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THE PRESERVATION  
OF  
IRON STRUCTURES  
FROM RUST.

NATURE AND COMPOSITION OF BAR AND CAST  
IRON, AND THEIR BEHAVIOR UNDER THE  
INFLUENCE OF THE ATMOSPHERE,  
MOISTURE, ACIDS, ETC.

*J. H. Siemann*

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1890.



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## BAR IRON.

Good bar iron contains as its important constituent from  $\frac{1}{4}$  to  $\frac{1}{2}$  per cent. of carbon. It also usually contains more or less Sulphur, Phosphorus, Silicon and Manganese, the two former exerting a deleterious effect, silicon less so, while manganese is not only not harmful, but in many cases beneficial.

The color of bar iron is light gray, sometimes bluish gray, almost silver white, sometimes dark gray ; varying with the amount of the above mentioned materials it contains. Its specific gravity varies from 7.3 to 7.9. It expands  $\frac{1}{143000}$  of its length for one degree of heat. Compared with cast iron, its strength is 1.12 times, its extensibility 0.86 times, and its stiffness 1.3 times.

A piece of bright bar iron can be kept in perfectly dry air, or in water free from air, for a long time, before it begins to lose any of its polish by oxidation; but just as soon as moisture and air combined have a chance to act on it, oxidation sets in and the iron rusts, which increases more rapidly the more carbonic acid is present. This latter, when no other acid is present, is undoubtedly the chief cause of the rusting of iron, although iron may be kept in a dry atmosphere of carbonic acid without showing any signs of rust whatever. According to Marshall Hall, iron in water saturated with carbonic acid rusts very rapidly, with a visible evolution of hydrogen gas. Not only do electronegative and distinctly acid substances, like car-

bonic acid, cause iron to rust, but likewise fully neutral salts accelerate the action when dissolved in water in which iron is immersed, or when strewn over the surface of iron in a damp atmosphere. In this case the iron rust seems to consist of a very basic oxide, containing a slight portion of the acid of the dissolved salt. If in place of a neutral salt an alkaline salt be dissolved in water, such as caustic potash or caustic lime, and polished iron be put into the solution, the rusting is entirely suspended.

## CAST IRON.

The chemical difference between bar and cast iron consists principally in the fact that the latter contains a much larger percentage of carbon. It also contains more impurities, Silicon, Sulphur, Phosphorus, Arsenic, Zinc, Manganese, Titanium, Chromium, Aluminium, Magnesium and others. There are two varieties of cast iron, the white and the gray. In the white variety all the contained carbon is chemically combined with the iron; in the gray variety, on the other hand, only a portion of the carbon is chemically combined, while the rest exists in the form of admixed graphite. The color of cast iron varies from silver white, containing the largest amount of combined carbon, to a dark, almost black, gray.

Cast iron expands  $\frac{1}{162000}$  of its length for one degree of heat; exposed to direct sun ray it expands  $\frac{1}{1000}$  and shrinks in cooling  $\frac{1}{85}$  of its length.

Cast iron under the same circumstances as those described under bar iron, oxidizes less readily than gray iron, and this again less readily than bar iron,

provided that it does not contain a large amount of sulphur, and is not very much contaminated with easily oxidizable substances.

### THE USE OF OIL COLOR (PAINT).

The greater portion of so-called compositions, consisting generally of solutions of resins or tar products for protecting iron from rusting, are not only valueless, but even in not a few instances absolutely deleterious. Up to the present time no substance has been found which, under varying atmospheric influences, and especially under great changes in temperature, will adhere so firmly to iron as a good drying oil paint. Even in those cases (comparatively rare) where a coating with some other metal, less liable to oxidation, is found useful, oil color is still the last resort, when in the course of time the metallic coating disappears or is worn off. But the painting of iron as done heretofore is far from satisfactory, especially where this material is used in ship-house or bridge building, it is found that ordinary oil paint does not properly protect it against the disturbing action of the atmosphere, owing to the fact that in a comparatively short time the paint or composition becomes cracked or broken, and though these crevices may be microscopical, they are sufficient to allow air and moisture to penetrate to the iron, and the work of destruction thus begun continues, in many cases, unsuspected, till eventually the whole structure is honeycombed and rendered useless. So that it is all important to have a material for the protection of iron which will last a reasonable length of time.

## IMPORTANCE OF THE PRIMING COAT.

In painting iron, the vital point is the first, or so-called priming coat ; if this is not properly applied the result is a failure, even though the later or finishing coats are put on in the most skillful manner, for though these may adhere to one another, yet if the underlayer or priming does not adhere to the iron itself, the whole will gradually crack and chip off, scale.

## RED-LEAD AND METALLIC OXIDES.

Formerly Red-lead was exclusively used as a priming coat. For the last few years the so-called "metallics" (oxides of iron) have come into use for painting iron. It has been much disputed which was the better for this purpose, and it has been frequently asserted, though no confirmatory evidence has been offered, that Red-lead, by its decomposition, causes the destruction of the oil coating. I am convinced that there is no substantial foundation for this belief, for thorough tests and examinations of old iron coatings, extending over several years, have failed to reveal any decomposition of the Red-lead. Metallic oxides do frequently exert a deleterious influence, if not carefully prepared. Many of them being made by burning iron vitriol (sulphate of iron or copperas) are not thoroughly washed, and consequently retain a greater or less amount of sulphuric acid. A simple test will show the presence of sulphuric acid. If an oil color, wash with benzine, to remove the oil, treat the dry powder with hot water, settle and filter, add a

few drops of muriatic acid, and then add solution of chloride of barium. A white precipitate indicates the presence of sulphuric acid or a salt thereof.

## THE VEHICLE OR VARNISH.

It must be evident to anyone who has made a careful study of this matter that the trouble is with the vehicle, and that to prepare a priming coat which shall be lasting and serve to preserve the iron, the varnish must itself be of the right character.

## PREREQUISITES OF THE PRIMING COAT.

Now what are the prerequisites of a priming coat on iron to render it adherent and lasting? First, it must dry well, viz: It must form an unbroken elastic coating, not necessarily hard, rather otherwise, as being less liable to crack or break under expansion. Second, it must not be too thick. Third, it must be applied in a thin layer. Fourth, the surface of the iron must be clean and free from rust or old paint. Good drying (or setting) in order that no moisture may be deposited on the iron, when the air becomes cooler; this occurs generally after sundown. In such case the moisture forms an emulsion with the varnish, and as a consequence the varnish never dries evenly; hence, when practicable the work should be gone over during the morning hours and in dry weather. Moisture may likewise be deposited by radiation of heat from the iron. The radiation of iron like that most other metals is comparatively slight, but Mellom's investigations

have shown that it is very perceptibly increased when the metallic surface is coated with varnish.

The priming coat should be sufficiently thin to insure perfect contact with the minutest inequalities of the surface ; if this is neglected, which is usually the case when the varnish is too thick, and the painter does not give the requisite attention to this point, the coating tears or breaks easily when the metal expands, air and moisture enter through the crevices thus formed, and the consequent rusting of the iron soon undermines the whole coating.

The coating should be applied in a thin layer, as a layer of varnish on iron or any other non-porous substance dries but slowly. If the coating is thick, only the outer surface dries, forming a thin skin, leaving the under parts fluid for a long time. The surface of the iron should be clean and free from rust, and in most cases this can be accomplished by scrubbing and brushing the surface well with ordinary kerosene, which removes any grease, loosens the scale, and assists in carrying the varnish into the minute cavities of the metal. To a certain extent it retards the drying of the varnish, but this is more than compensated for in the end by its beneficial action.

## QUICK DRYING VARNISHES.

In order to produce a priming coat, having the above described qualities, it seems self-evident that the varnish or medium is the all-important thing, but heretofore no varnish has been produced possessing just these qualities. Quick drying varnishes may be produced in two ways: either the varnish is boiled till it becomes

thick, or so-called dryers may be added to it. But a thick varnish is unsuitable for reasons given above, viz: that it does not come into intimate contact with the whole surface of the iron. The only liquid dryer of any value is nothing more or less than a thick boiled oil, thinned with turpentine, but for the following reasons this cannot be advantageously used.

### BENZINE AND TURPENTINE.

Neither benzine nor turpentine are suitable for thinning varnish to be applied to iron. By their rapid evaporation they cool the iron and thus cause a precipitation of moisture, producing an emulsification of the varnish, as above mentioned; which shows itself by the varnish becoming cloudy. Furthermore, turpentine always contains more or less organic acid, ambic, formic, acetic, which is increased, by exposure to the air and consequent oxidation, and this in time reacts on the iron.

### TIEMANN'S IRON PRESERVATIVE.

After much study and experimenting, and profiting by the experience of others who have given careful attention to this matter, I have produced a varnish, which, while possessing the requisite fluidity, dries well, though never becoming absolutely hard, forming an india rubber-like coating on the surface of the iron, expanding and contracting with the metal, and forming a coating impervious to air and moisture.

J. H. TIEMANN.

BROOKLYN, N. Y., April 15, 1890.

## TIEMANN'S IRON PRESERVATIVE.

For the preservation of all structural iron work, house, ship, railroad and bridge buildings, tin roofs, smoke stacks, boilers, iron railings, etc.

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